Laser ionisation of polonium isotopes measured at ISOLDE

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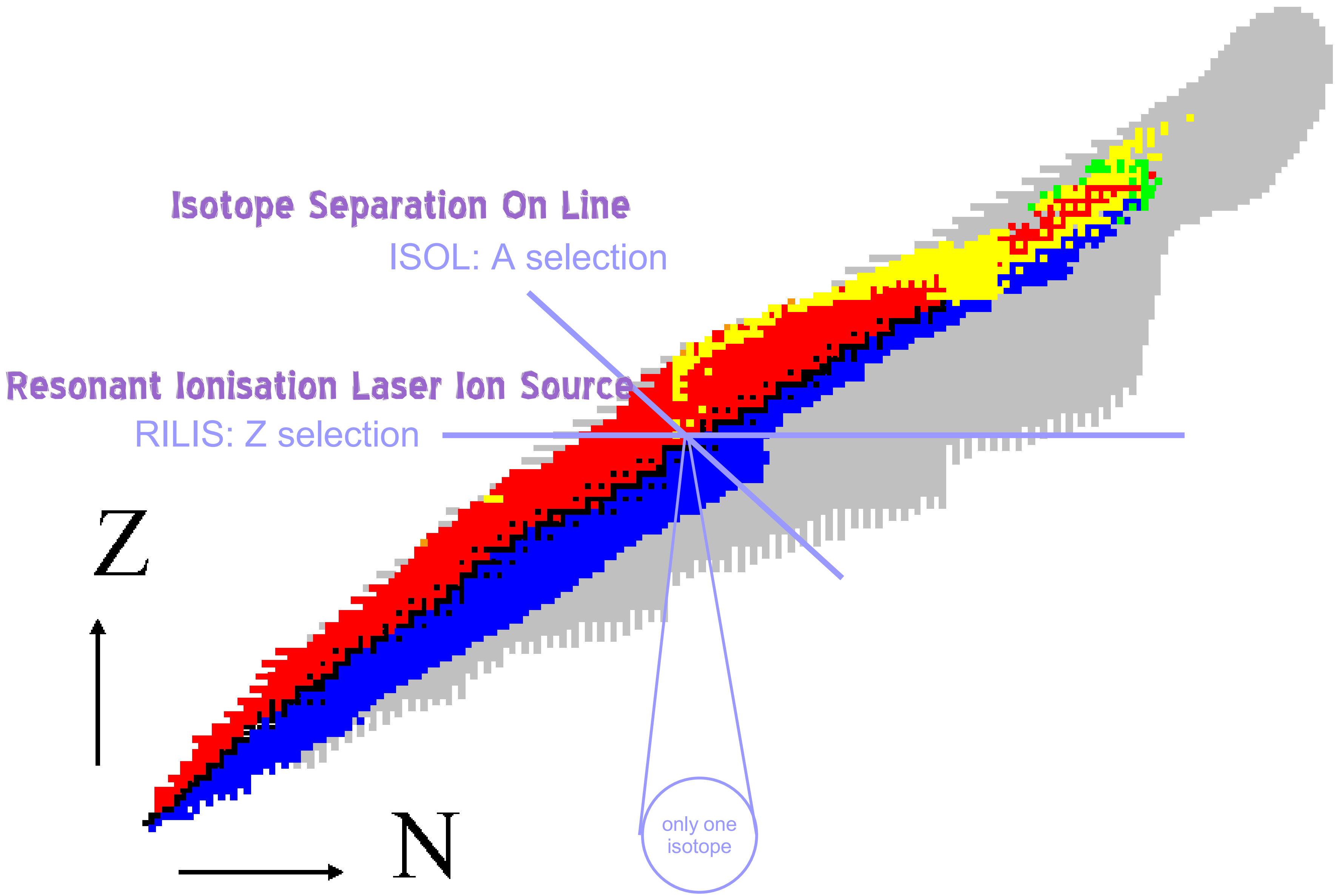
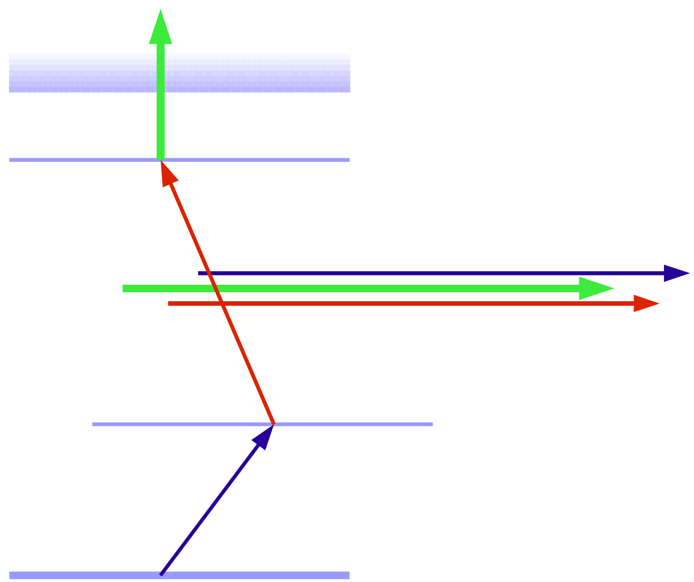
Outline

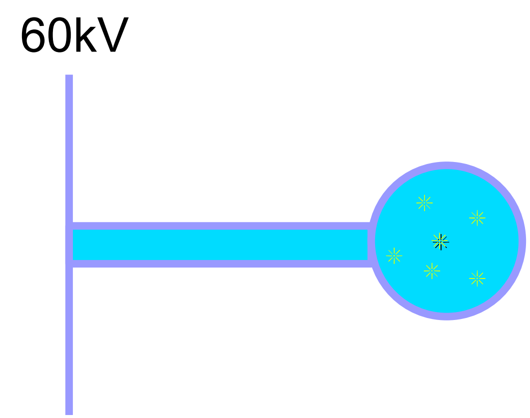
- Polonium laser ionisation
  - RILIS @ ISOLDE
  - Spectra, saturation, yields, ...
- Use of laser ionised polonium beams
  - In-source laser spectroscopy
  - Nuclear spectroscopy
  - Coulomb excitation

RILIS vs ISOL: The Ultimate Isotope Selection



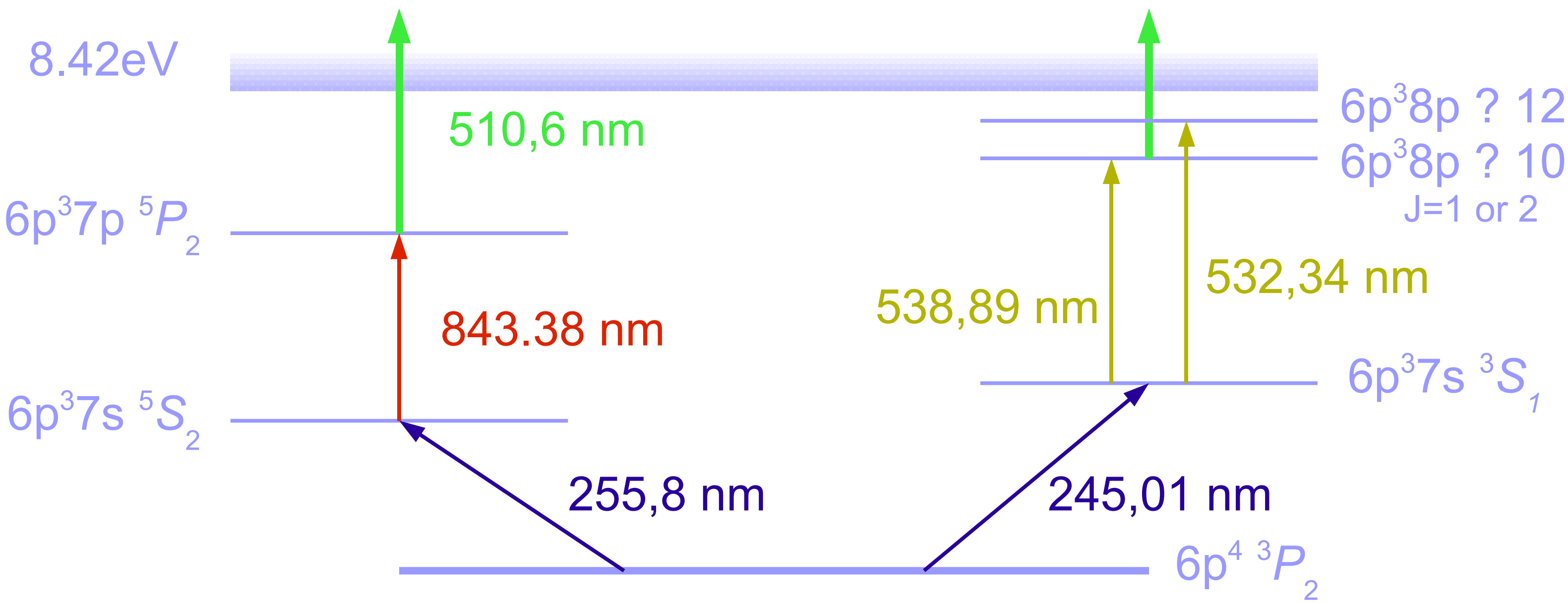
Laser ion sources



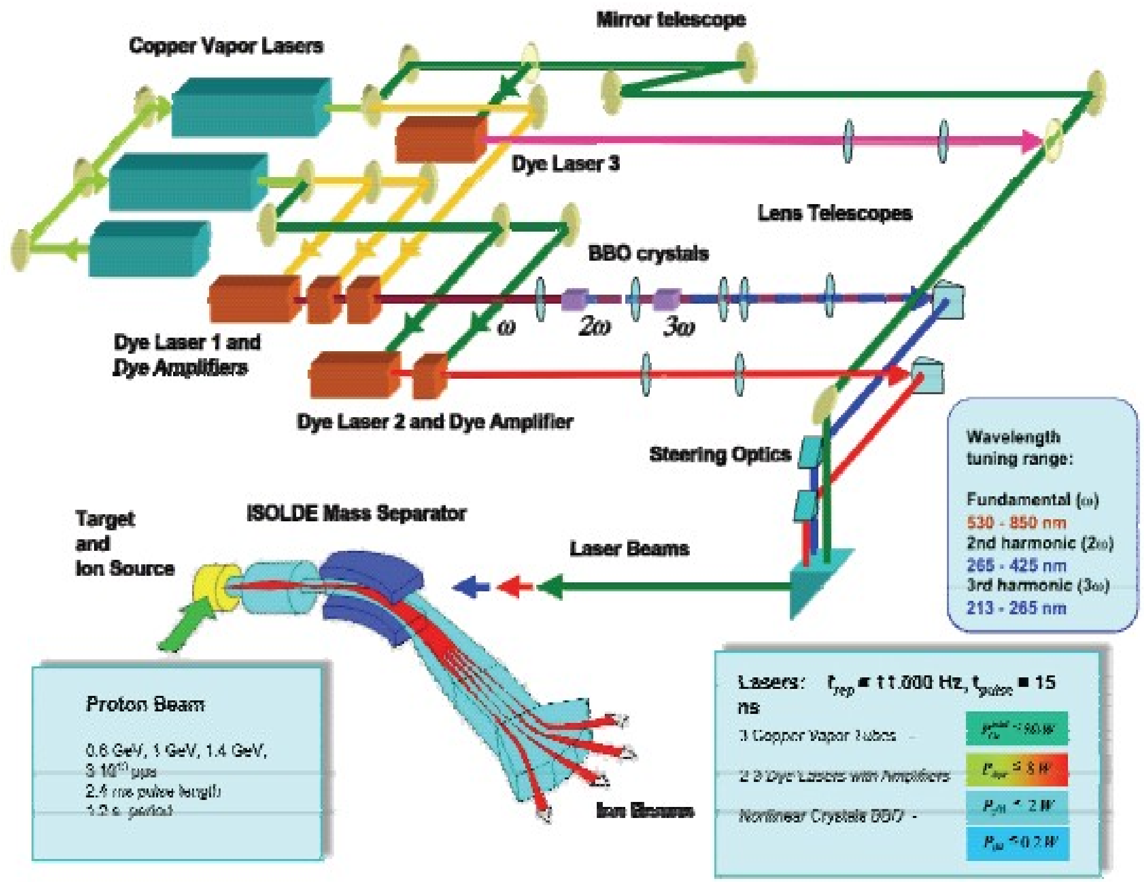


- Atom source (hot cavity)
- Transfer tube where the ions meet the lasers
- Acceleration electrode
- Lasers on the proper frequencies and the proper timing

Po excitation schemes

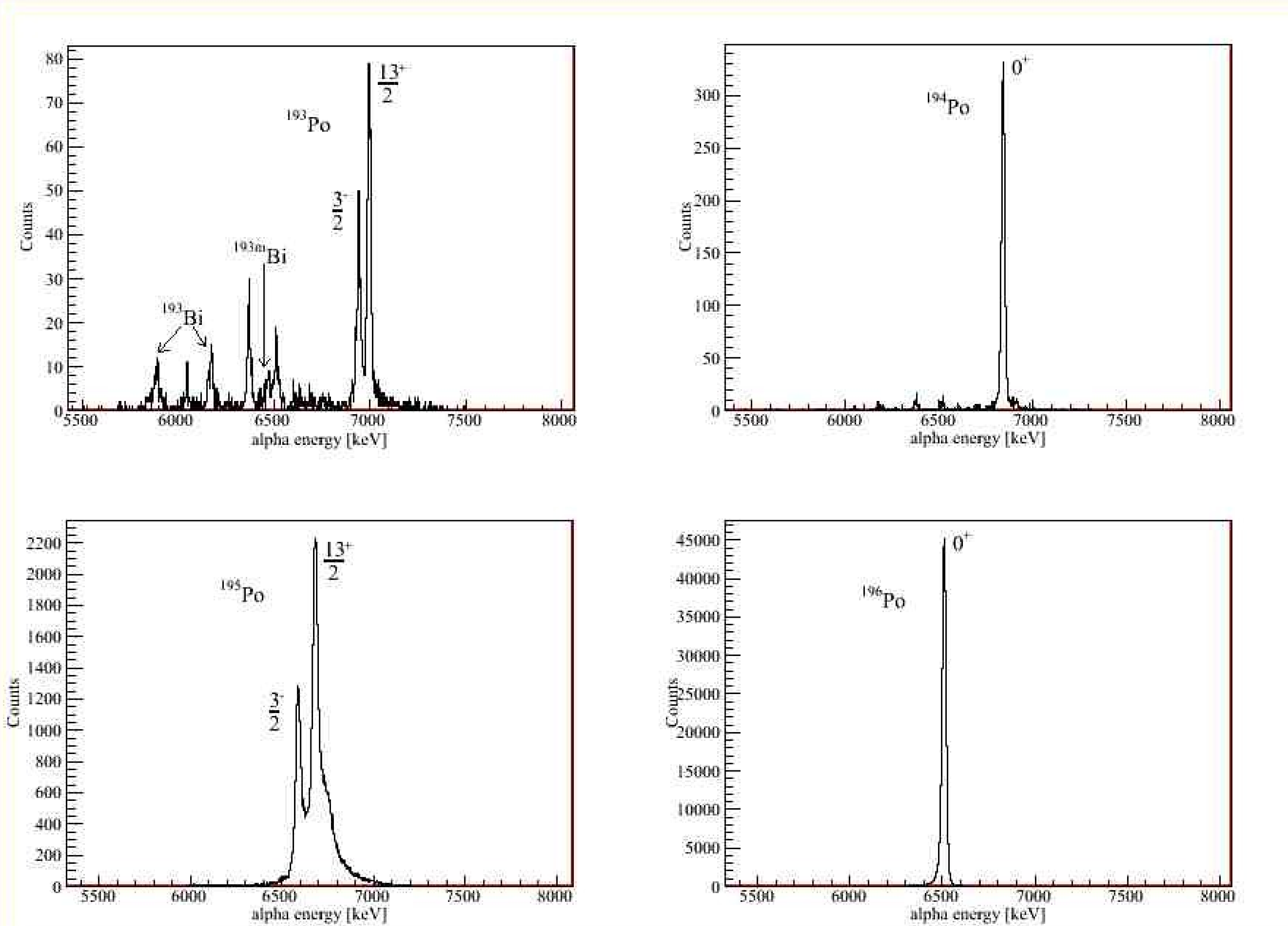


ISOLDE RILIS

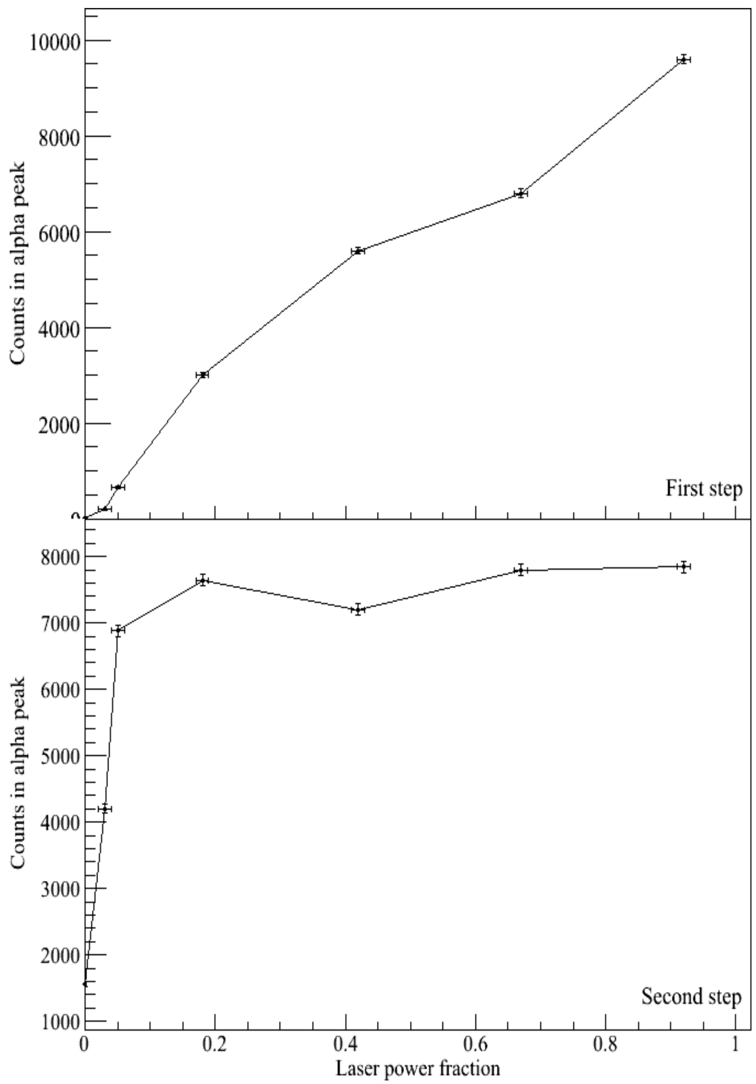


Bruce Marsh, The ISOLDE RILIS, Poznan LASER workshop 2006

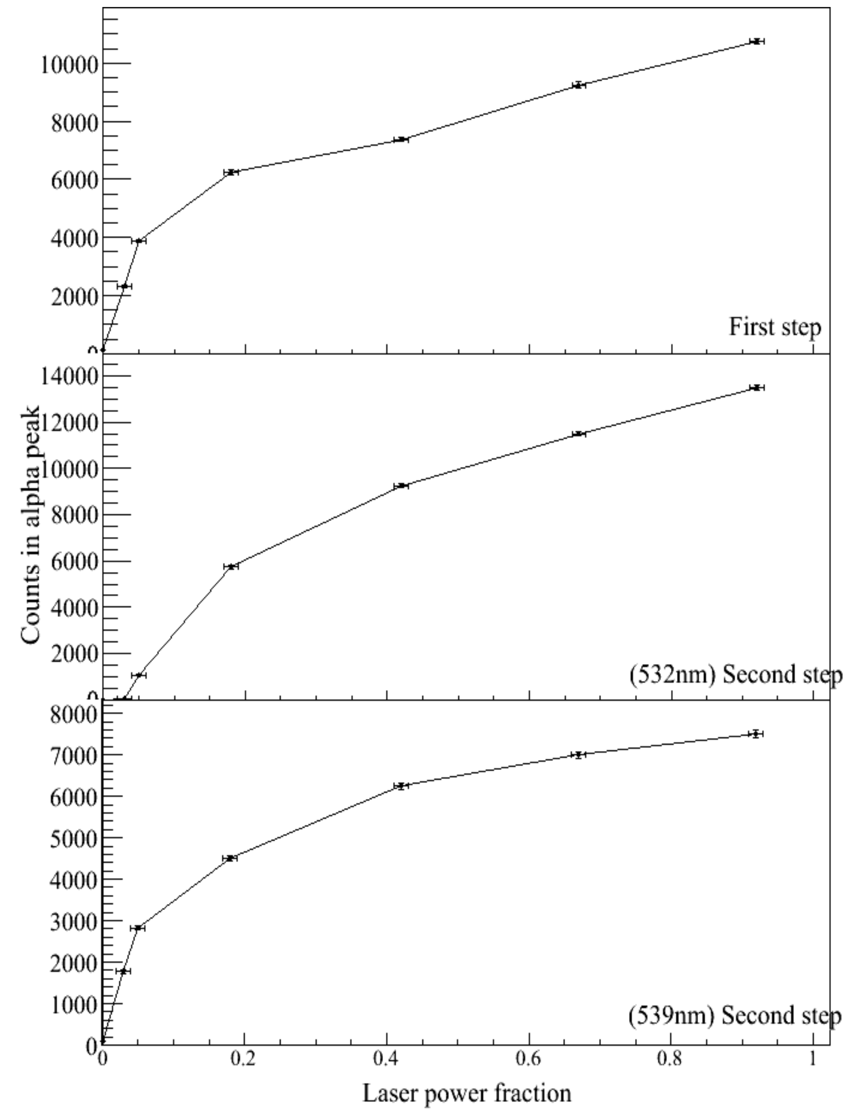
Po α Detection



Laser saturation

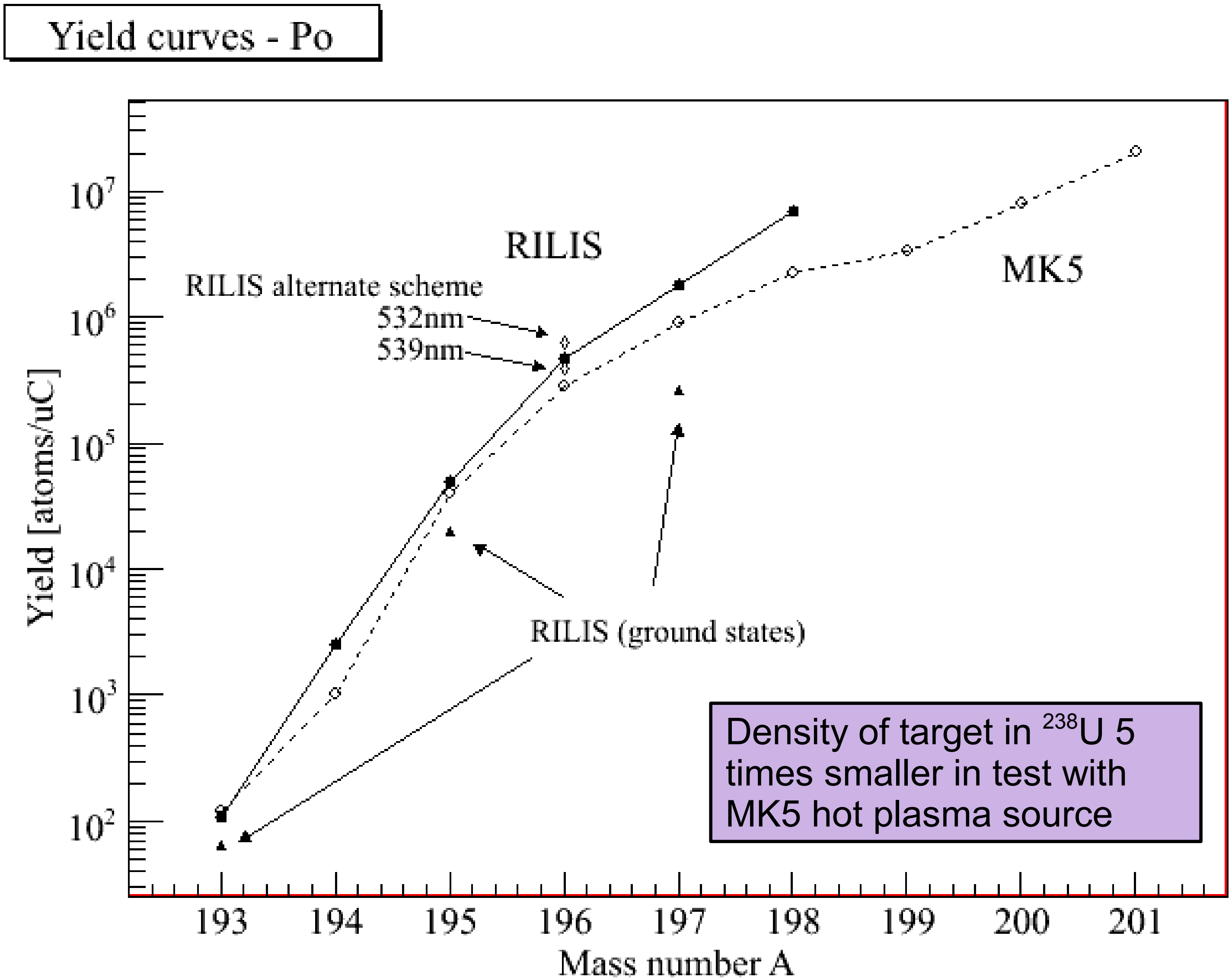


First scheme



Second scheme

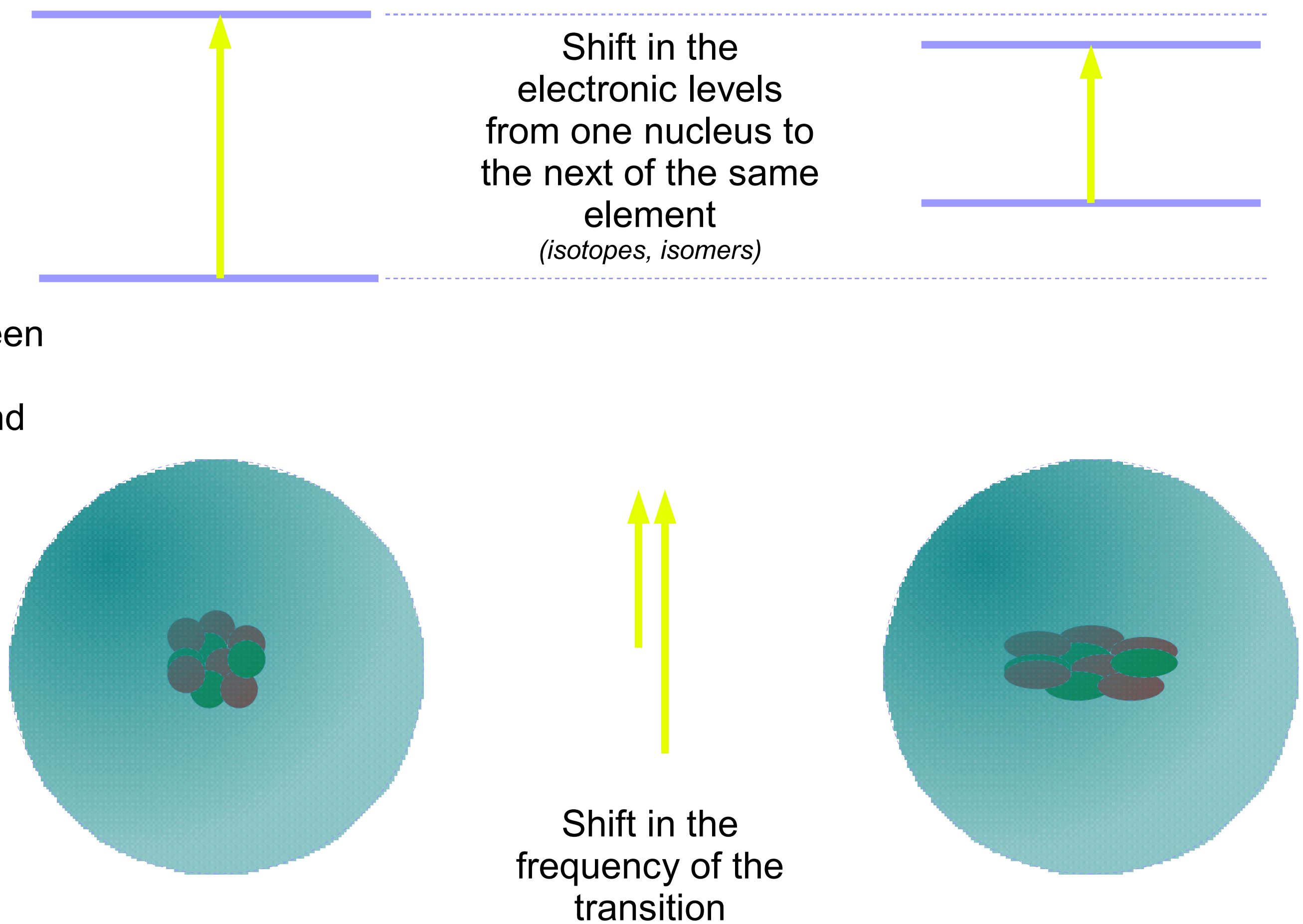
Po Yields



Density of target in ^{238}U 5 times smaller in test with MK5 hot plasma source

Isotope Shift

Interaction between a nucleus wavefunction and an *s*-electron



$$\Delta \nu \approx F \cdot \delta \langle r^2 \rangle + Mass\ Shift$$

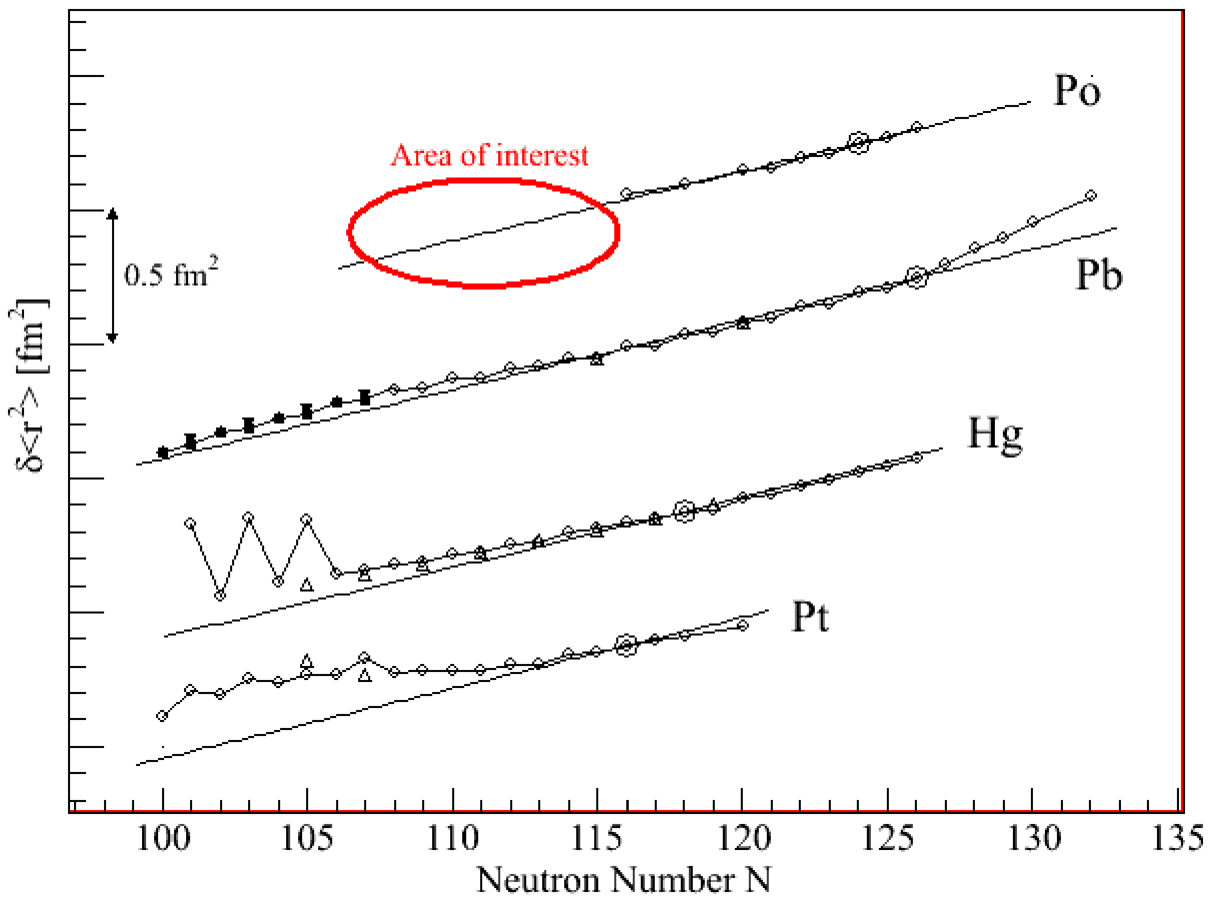
Atomic Spectroscopy

- In flight spectroscopy
  - + Doppler compression of fast-beam *(improved resolution)*
  - - Creation of the beam *(external ion source)*
  - - Manipulation for detection *(neutralisation, polarisation, fluorescence, ...)*

Appropriate for heavy elements
Po detection by α-decay

- In source spectroscopy
  - - Doppler broadened sample *(thermal distribution of the source)*
  - + No need to create a beam *(spectroscopy is the source)*
  - + Simple detection of the flux of ions *(beam current, nuclear spectroscopy,...)*

Po $\delta\langle r^2\rangle$



Hg = G. Ulm et al., Zeit. fur Phys. A 325, 247 (1986) , Pt = Le Blanc F. et al., Phys. Rev. C 60, 054310 (1999), Pb = De Witte H. et al., to be published, Po = Kowalewska D. et al, Phys. Rev. A 44, 1442R (1991)

Po Dipole moments

Po nuclear spectroscopy

- Extensive study has been made on the even isotopes and fine-structure in the α-decay has been evidenced
- Odd isotopes are formed as a coupling of a neutron to the even isotope core
- Fine-structure in the a-decay of 191Po has been observed
- Isobarically cleaner beams (and maybe even isomerically separated beams) are required to study the heavier polonium isotopes
- Interest in measurement electron conversion with a reduced Tl isobaric contamination

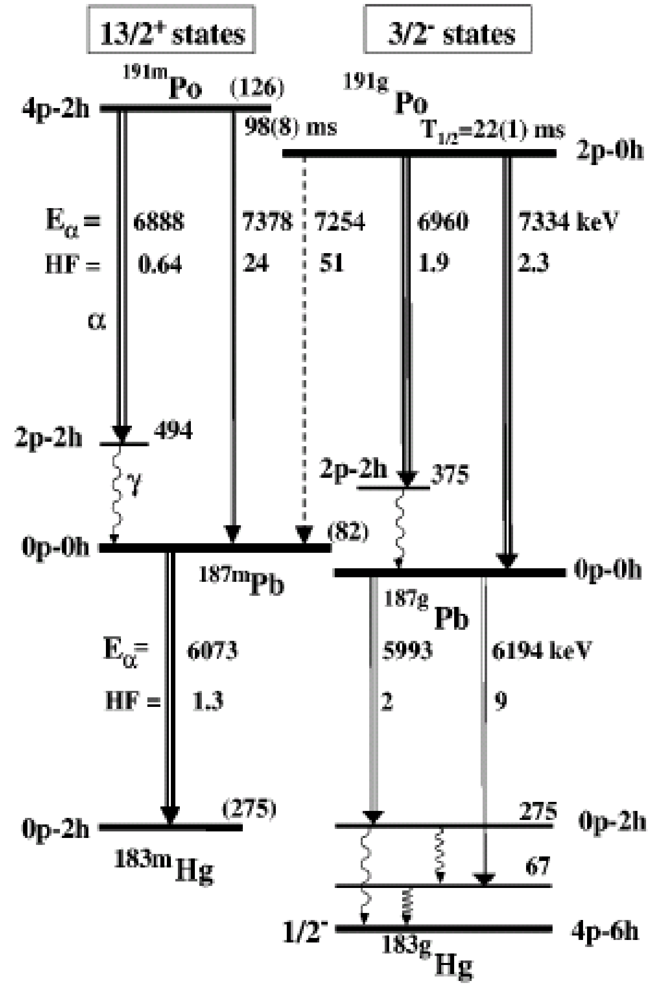


FIG. 2. Proposed alpha-decay scheme of ^{191m,g}Po. The uncertainty of the excitation energy of the isomeric state in ^{191}Po, ^{187}Pb, and ^{183}Hg is typically 20 keV. Note that the spin and the parity of ^{183g}Hg is $1/2^-$.

'Hindered (Δl=0) alpha decay and shape staggering in ^{191}Po", A.N. Andreyev et al., PRL82 (1999) p.1819

- Motivation
  - Probing the structure of excited levels
  - Each transition probes only one component of the mixed ground state
  - Complete information from energy levels

- Technique
  - Safe Coulomb excitation at REX-ISOLDE with MiniBall
  - First heavy ion measurement this summer with Hg isotopes

Conclusion & Outlook

- Laser ionisation of polonium was achieved successfully for the first time by RILIS-ISOLDE.
- This provides a cleaner beam to extend the study on the neutron deficient isotopes.
- A proposal shall be defended before the CERN-INTC this February to request beam time this summer for the study of isotope shift, hyperfine structure and nuclear spectroscopy.
- A test case on heavy CoulEx with REX-ISOLDE and MiniBall (Hg) has been accepted and shall be carried out this summer before going for polonium.

Collaboration

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